

I. Introduction and Executive Summary

From July 5th through July 11th, 2002, customers in the City of Medford experienced a series of interruptions in their electric service. Many customers were affected several times, with all but one outage ranging from 39 minutes to 3 hours and 40 minutes. The July 9-10th outage did affect customers from 3 hours and 21 minutes to 27 hours and 33 minutes. By letter dated July 10, the Department directed Massachusetts Electric Company (“Mass. Electric” or “Company”) to provide a detailed description of the causes of the Medford outages, as well as information regarding the Company’s distribution system in that area. This report responds to the Department’s request.

Prior to the outages that commenced July 5th, the distribution system provided this area of Medford reliable service. Indeed, the distribution system in that area was designed with a level of redundancy to minimize the impact of a problem on one part of the system from becoming a prolonged service interruption to customers. Upon the occurrence of each of the outages, Mass. Electric, in accordance with its standard practice, sought to determine the cause of the outage, and restore power as quickly as possible.

After multiple attempts to restore the existing supply system, the Company devised an interim solution to provide electric service to customers and began extensive testing of the cables out of service. The Company concluded that two underground 23 kV subtransmission lines, the 2333M and 2398M lines between the Wellington #11 and Medford #9 substations, had significant problems that could not be fixed. The Company immediately began construction to install two new underground lines. Although a project of this magnitude could normally take as long as a year to plan, design, and implement, the Company mobilized substantial resources into Medford to get this solution in place as quickly as possible. At the

time that this report was written, one line is energized and fully operational, and the Company anticipates that the other line will be energized and become fully operational within the next two days (by July 21st).

The Company understands that customers find these outages unacceptable, and the Company is taking several steps to prevent such outages in the future. The Company has contacted all affected customers in Medford advising them of the steps Mass. Electric is taking to restore reliable service. In addition, Mass. Electric has volunteered to reimburse customers for food spoilage resulting from the extended outage on July 9 and 10, and has set up a toll-free number and provided a mobile customer service center to process claims. The Company is also working with the Mayor of Medford, the Medford City Council members, other municipal officials, as well as Medford's members of the State Legislature to give them current information on the status of repairs and seek their input on issues.

In this report, the Company describes the Medford distribution system, the outages, Mass. Electric's immediate and long-term response, maintenance of the Medford distribution system, and the Company's customer outreach efforts.

II. Supply to Medford

Engineering (one-line) diagrams detailing the distribution system in Medford are attached as Exhibit A. An area map with the distribution system superimposed is attached as Exhibit B.

Two supply substations in Malden, the Everett #37 at 170 Medford Street in Malden and the Malden #5 at 55 Center Street in Malden feed four 23 kV distribution substations in Medford. These four distribution substations are the Wellington #11 at the intersection of

Middlesex Avenue and Woodruff Avenue, the Medford #9 at 56 Salem Street, the Coddington #64 on Coddington Avenue, and the West Medford #17 at 7 Playstead Road. Four direct buried underground 23kV subtransmission lines deliver the power between the substations. In addition, at these substations, the power is stepped down to 4 kV to be distributed to end-use customers through a combination of overhead and underground lines.

Each of the four underground 23kV subtransmission lines mentioned above is three-phase, containing three conductors. The lines designated as 2398 and 2333 both originate at the Wellington #11 substation and proceed to Medford #9 substation, and then to Coddington #64 substation. Between the Wellington #11 substation and the Medford #9 substation, these lines are referred to as the 2398M and the 2333M circuits. The direct buried cables comprising these circuits are 1,000,000 circular mils aluminum, cross-linked polyethylene, with a 50,000 circular mils shield and were installed in 1970. The system was designed such that either the 2398M or the 2333M circuit could carry the load at Medford #9. (These are the lines that the Company is replacing, as described in more detail below.) Between the Medford #9 substation and the Coddington #64 substation, the 2398 circuit is referred to as the 2398C and the 2333 circuit consists of two parallel sets of cables, the 2333X and the 2333C. The 2333C line is 2/0 copper, paper insulated with lead sheath and was installed in 1931. The 2333X and 2398C circuits are 4/0 aluminum cross-link polyethylene. The 2333X was installed in 1988 and the 2398C was installed in 1972. These two circuits follow the same route in an underground manhole and duct system underground, and serve the same load. The supply system between Medford #9 and Coddington #64 was designed such that either the combination of the 2333X and 2333C or the 2398C could carry the load.

The 2314 circuit runs from the Wellington #11 substation to the West Medford #17 substation. Between Wellington #11 and Medford #9 this cable is mostly 250,000 circular mil copper, paper insulated, lead sheath cable installed in 1953. From Medford #9 to West Medford #17 it is 350,000 circular mils copper, paper insulated, lead sheath installed in 1955. The 2313 circuit runs from the Malden #5 substation to the West Medford #17 substation. Between Malden #5 and Medford #9 this cable is a 350,000 circular mil copper, paper insulated, lead sheath installed in 1931. From Medford #9 to West Medford #17 it is a combination of 350,000 circular mil and 250,000 circular mil copper, paper insulated lead sheath most of which was installed in 1955. The 2314 and 2313 circuits occupy the same manhole and duct system from the Medford #9 substation to the West Medford #17 substation. The 2314 is direct buried in the same right of way with the 2398M and 2333M from Wellington #11 to Medford #9. This part of the local supply system was designed such that either the 2313 or the 2314 could carry the load at West Medford #17.

A summary of the circuit information is set forth in the following table.

Circuit Number	Connection Points	Conductor & Insulation	Installation Date
2398M	Wellington #11 – Medford #9	Aluminum; Cross-linked polyethylene	1970
2333M	Wellington #11 – Medford #9	Aluminum; Cross-linked polyethylene	1970
2398C	Medford #9 – Coddington Ave #64	Aluminum; Cross-linked polyethylene	1972
2333X	Medford #9 – Coddington Ave #64	Aluminum; Cross-linked polyethylene	1988
2333C	Medford #9 – Coddington Ave #64	Copper; paper, lead sheath	1931
2314	Wellington #11 – W. Medford #17	Copper; paper, lead sheath	1953
2313	Malden #5 - W. Medford #17	Copper; paper, lead sheath	1955

The Company uses these types of cables throughout its service territory, and they are commonly used by other utilities. The age of the cables is also common throughout Mass. Electric and other utilities. The Company regularly maintains the distribution system in Medford, as is described in more detail in Section V below.

Until the recent outages, this system has worked well for Medford. Over the past ten years, there have been 12 cable failures on the 2333 line and 5 cable failures on the 2398 line.

Ten Year History by Cable Section

Circuit	Cable Failure	Joint Failure	Total
2333M	2 (1 dig in)	3	5
2333C	5	1	6
2333X	0	1	1
2398M	0	2	2
2398C	1	2	3
	8	9	17

Because the cables back each other up, however, these incidents have been virtually invisible to most customers. Medford's frequency of customer outages, measured by SAIFI, or System Average Interruption Frequency Index, ranged between 0.54 and 2.17 outages per customer per year from 1995 through 2001 with an average SAIFI of 0.98 outages per customer per year over this seven year period, as shown on Exhibit C. This compares to average Mass. Electric SAIFI values of 1.29 for the same period. The annual average duration of customer outages, measured by SAIDI, or System Average Interruption Duration Index, ranged between 22 and 80 minutes of interruption per customer per year served from 1995 through 2001 with an average SAIDI of 49 minutes per year over this seven year period, as shown on Exhibit D. For the same period, Mass. Electric's average SAIDI value was 97 customer minutes. In fact, the two circuits that Mass. Electric is replacing, the 2398 and 2333

circuits, had a negligible effect on both the duration and frequency of Medford's outages from 1995 until early July.

III. Outages of July 5 through July 11, 2002

A series of outages occurred between July 5 and July 11, 2002 in Medford. The first four outages affected 6,400 to 9,700 customers and ranged in duration from 39 minutes to 3 hours and 40 minutes. The fifth outage that began on Tuesday, July 9th affected approximately 7,000 customers and lasted from 3 ½ hours to 27 hours and 40 minutes. The extended outage occurred when both our primary and back up system cables failed. This is like changing a flat tire and having the spare immediately go flat, too. The system was designed with redundancy, but the redundant circuit failed at the same time as the primary circuit. This was a very unusual occurrence. The sixth outage on July 11th affected about 4,000 customers for 55 minutes. After the outage on July 11th, the Company was unable to serve Anheuser Busch for about two days and Tufts University for six days due to the limitations of the temporary supply arrangements put in place. Many other customers were affected several times and were extremely inconvenienced. For the most part, the outages were caused by equipment failures, although the initial event on July 5 was caused by a squirrel contact at the #2 transformer at Malden #5 substation which interrupted service to five feeders. Customers served through the Medford #9 and Coddington #64 substations, and customers served directly from the 23kV system (Tufts and Anheuser Busch) were affected the most. Exhibit E provides detail on each outage, including the cause of the outage, the

number of customers affected, and the duration of the outage. Engineering analysis is required to determine the root cause of the cable failures. These investigations are ongoing.

IV. Service Restoration

From the onset, the Company took several steps to repair the outages and restore service to customers as quickly as possible. The Company quickly realized that these steps would not be sufficient as a long term solution, and thus proceeded on two tracks: (1) to find a temporary solution that would restore service as soon as possible to as many customers as possible, and (2) to find a long-term solution for providing reliable, firm service to the area. Mass. Electric describes the short-term solution in IV.A and the long term solution in IV.B below. The Company has mobilized approximately two hundred employees and contractors working around the clock to get the power back on and keep it on.

As of July 19, 2002, the Company has made significant progress in implementing the long-term solution, with one circuit completely replaced and energized, and the second is expected to be energized over the July 20-21st weekend. Once both are energized, firm service including redundancy between Wellington #11 and Medford #9 will be restored.

A. Short Term Solution

As Exhibit E shows, the 2398 and 2333 circuits repeatedly failed during this period. During the first few outages, the Company was able to restore service within two and a half hours. With the concurrent failure of both cables on the evening of July 9th, the Company was concerned that the time it would take to find, test, and correct the faults would be long, and it did not want to leave customers without power during that time.

On Wednesday, July 10, 2002, the Company implemented its short-term solution. It restored service by temporarily rerouting the 2314 line so that it powered the Medford #9 substation. The 2313 continued to provide power to the West Medford #17 substation, but without the back up of the 2314. To supplement the 2314 line, the Company installed six megawatts of portable emergency generation at the Coddington #64 substation. The generation could be used to supplement the supply to the area in the event that the 2314 line was overloaded. As described in the Company's reports in D.T.E. 01-68, first on October 29, 2001 and next on June 7, 2002, the Company had contracted to have three units of portable emergency generation, two megawatts each, available should the Company need it. The Company has since contracted for another six megawatts, for a total of twelve megawatts of portable emergency generation on stand-by.

On July 15th, due to an unusually high loading of the 2314, the Company started the 6 MW of emergency generation at Coddington #64. At 11am on July 15th about 2,000 customers on 2 feeders out of Coddington #64 were transferred to this generation to relieve the load on the 2314 feeder. These customers experienced a short outage (less than 10 minutes) when they were brought on and off the generation. In addition, they experienced 3 short outages due to the balancing of the generators. These customers were returned to the 2314 line at 4:30am on July 16th. We do intend to keep the emergency generation at Coddington #64 until the long-term solutions are implemented.

These interim supply options were not sufficient to provide service to Tufts University and Anheuser Busch. The Company offered assistance to both of them, and other customers, to find emergency generation. Both Tufts and Anheuser Busch did install temporary emergency generation. By Saturday, July 13th, the Company was able to provide an alternate

13 kV supply to Anheuser Busch. Anheuser Busch actually transferred to this new supply on July 16th at 4:00am. Anheuser Busch will remain on this supply permanently. With the completion of the installation of the new 2333 cable on July 17th (as described below), Mass Electric again had supply capacity available to serve Tufts and informed Tufts of this at approximately 1:30pm on the 17th. Tufts returned to the Mass Electric system on July 18th starting at 5:00pm. The Company has also developed a new supply arrangement to enhance service to Tufts, which is described in IV.B below.

B. Long Term Solution

With the 2398M and 2333M circuits out of service, the Company was able to complete its testing on July 11th and determine that both of these circuits needed to be replaced to ensure reliable service to the area. The Company then moved quickly to implement this long-term solution. At this point, the 2333M circuit has been replaced and energized, and the Company anticipates that it will energize the 2398M circuit over July 20-21st weekend. A project like this would normally take a year to plan, engineer, and construct. The Company will complete this project in approximately eleven days.

Both new cables are a combination of 1,000,000 circular mils, aluminum and copper, cross-link polyethylene. New cables manufactured with this insulation technology are designed to perform well over an extended period of time either directly buried or in conduit. To expedite the installation, these cables are being directly buried in the ground in the existing right of way. The use of this route allowed the Company to proceed immediately to installation, utilizing existing easements without needing to get any new public or private

authorizations. Over the July 13-14 weekend, Mass. Electric personnel went door to door to inform all residents who would be affected by the Company's plans.

Prior to proceeding with this solution, the Company had also considered other supply alternatives. The Company altered its original overhead route design at the behest of the Mayor of Medford and the City Council in order to minimize the impact on the city's neighborhoods.

At present the Company is serving Tufts from taps on the 2333X circuit. The Company intends to build a new overhead line between Wellington #11 and the University. After completion of this new supply line, the Company will continue to maintain the existing taps off of the 2333X and 2333C circuits as a back up service.

After completion of additional testing of the 2398C cable, the Company has concluded that it should also replace this cable, and will pursue this project upon completion of the new overhead supply to Tufts. This cable replacement should enhance the reliability of customers served from the Coddington #64 substation.

V. Maintenance

The Company's maintenance procedures are described in great detail in the Company's October 29, 2001 filing in D.T.E. 01-68. A copy of the relevant pages is attached in Exhibit F.

Exhibit G contains the Company's Wellington #11, Medford #9, and Coddington #64 substation maintenance records. These records indicate that the substation was in good working order.

As is standard in the industry, the Company tests underground cables during installation and immediately after any repair at which time the cables are already out of service. Otherwise, the Company would generally have to create an outage to test the cables. A sample test result is attached in Exhibit H.

The Company performs an annual reliability assessment across its system to identify poorly performing circuits. Because of the redundancy built into the supply system in Medford, the prior outages on the supply cables in this area did not create a reliability problem. Therefore, prior to July 5th, the reliability assessment did not identify these cables as a problem and the Company had no indication from the assessment that the cables were approaching the end of their useful life. If it is expected that a cable is approaching the end of its useful life, samples are extracted and sent to a lab to determine if the insulation is breaking down. Based on the above, this was not done for these cables.

VI. Community Outreach

During the initial outages of July 5 – 9, when the Company's customers experienced short duration outages, the Company was in contact with and met with the Mayor of Medford to keep him apprised of the situation. Mass. Electric also met with the state senator and state representatives from Medford to apprise them of the situation. In addition, the Company responded to any customer and media inquiries about the situation.

When both the 2333M and 2398M cables failed simultaneously at 5:00 pm on Tuesday, July 9th, Mass. Electric substantially increased its communications efforts with both city officials and customers. The Company activated its twenty-four hour municipal room. Typically during widespread emergencies this line is dedicated to enhancing communications

with local police and fire officials. The Company also contacted a number of its large commercial and industrial customers to inform them of the situation and provide them with the twenty-four hour dedicated phone number so that they could contact the Company if any problems arose. Mass. Electric has continued to keep this 24-hour line open and plans to do so until both the 2333M and the 2398M new cables are in service. On Wednesday, July 10th, company representatives visited small commercial customers that were impacted by this outage to keep them apprised of what the situation was. The Company has continued to respond to any customer inquiries that it receives. The Company also contacted either by phone or in person most of the larger commercial and industrial customers who were impacted by these outages.

On Friday, July 12th, the Company established the Mass. Electric mobile command center on Main Street in Medford across from Tufts Park. This center is staffed with Mass Electric personnel from 11 am to 8 pm who are there to meet with customers and listen to their concerns relating to these outages. It is also staffed with a claims adjuster who is accepting food spoilage claims from customers impacted by the extended outage on July 9th and 10th. The Company will continue to have this center available to our customers through Wednesday, July 24th (Monday through Saturday). The Company intends to have this center available at City Hall in Medford on Monday night, July 22nd. Mass. Electric has also established a toll-free claims number for customers (1-800-307-5256). On Monday, July 15th, Mass. Electric sent all of the customers in Medford impacted by these outages a letter (Exhibit I).

Company officials have been in constant communication with the Mayor of Medford throughout this time. Briefings were held with the Mayor as well as members of the City

Council to keep them apprised of not only the status of any outages but also of the Company's plans to remedy the situation.

With the installation of the back-up generation at Coddling #64, Company representatives met with abutters to explain what was taking place. When the generation was placed in service on July 15th, the Company revisited abutters and offered assistance in mitigating the impact of the generation. Three residents did accept the offer and stayed at a local hotel for the evening.

The new 2333M and 2398M cables are being installed in an existing right of way for which Mass. Electric has existing easements. On Saturday, July 13th company personnel visited with each existing homeowner to inform them of the construction that would be taking place. The project was explained and customers were given a phone number that they could reach someone from the company if they had any further concerns. Where individuals were not home, we left information along with a name and phone number for them to call to discuss this project. Mass. Electric has continued to have Company personnel on site during the construction to address any concerns that the neighbors may have.

VII. Next Steps

The Company will continue to expedite implementation of all elements of its long-term solution in Medford until they are complete. The Company will also work to resolve the claims it receives from customers promptly.

The Company is also in the process of identifying other cables in its service territory that are similar to the 2333 M and 2398 M. The Company intends to develop a process to evaluate the condition of each such cable and determine the appropriate corrective action,

based on its performance history, reliability impact, design configuration and installation methodology. The Company will conduct an incident analysis to seek the root cause of this event as well as other lessons learned. Findings will be communicated throughout the company and any recommended improvements to procedures or policies will be implemented promptly.

LIST OF EXHIBITS

- A. Engineering diagrams of the distribution system in Medford
- B. Map of Medford with the distribution system superimposed
- C. Frequency of customer outages in Medford (SAIFI)
- D. Duration of customer outages in Medford (SAIDI)
- E. Outages of July 5 – 11, 2002
- F. Maintenance procedures
- G. Substation maintenance records (no electronic version of this exhibit)
- H. Sample cable test result
- I. Letter to Medford customers